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CLAIMS

1. A method for implementing a force sensation design interface, said method comprising:

displaying said force sensation design interface on a display device of a host computer;

receiving input from a user to said force sensation design interface, said input selecting a type of force sensation to be commanded by said host computer and output by a force feedback interface device, said force feedback interface device including a user manipulatable object graspable by a user and moveable in a degree of freedom;

receiving input from a user defining physical characteristics of said selected force sensation;

displaying a graphical representation of said selected force sensation as characterized by said user, wherein said graphical representation provides said user with a visual demonstration of a feel of said characterized force sensation; and

commanding said characterized force sensation to said force feedback interface device coupled to said host computer such that actuators of said force feedback interface device output said force sensation on said user object in conjunction with said visual demonstration of said feel of said characterized force sensation.

receiving additional changes to said characterized force sensation from said user after said force sensation is output and displaying said additional changes in said graphical representation, wherein a force sensation modified in accordance with said additional changes is output by said actuators on said user object.

2. A method as recited in claim 1 further comprising storing a plurality of parameters characterizing said force sensation to a storage medium accessible to said host computer.

3. A method as recited in claim 2 further comprising accessing said stored plurality of parameters from an application program different than said design interface, said application program using said plurality of parameters to output said characterized force sensation during execution of said application program.

4. A method as recited in claim 3 wherein said application program is a game program.

5. A method as recited in claim 1 wherein a local microprocessor, included in said force feedback interface device and separate from said host computer, receives a command from said host computer to control said actuators to output said characterized force sensation.

6. A method as recited in claim 1 wherein a plurality of force sensations are selectable by said user, and wherein said selectable force sensations include conditions, effects, and dynamics.

7. A method as recited in claim 1 wherein said user may select an advanced mode or a simple mode of graphically representing said force sensation in said force sensation design interface.

8. A method as recited in claim 5 wherein in said advanced mode, a force versus user object motion profile is displayed, wherein said user may adjust parameters of said selected force sensation by dragging displayed control points of said profile.

9. A method as recited in claim 1 wherein said user may characterize said force sensation independently in different directions of a degree of freedom of said interface device.

10. A method as recited in claim 1 wherein said selected force sensation is a damping condition, and wherein said graphical representation includes an image of a column of liquid into which said user may move a controlled graphical object by moving said user object such that said user feels said characterized damping force sensation.

11. A method as recited in claim 1 wherein said selected force sensation is a spring condition, and wherein said graphical representation is an image of said user manipulatable object and an image of a spring, wherein said user may adjust a thickness of said spring to adjust a stiffness of said spring condition.

12. A method as recited in claim 1 wherein said selected force sensation is a slope condition, and wherein said graphical representation includes an image of a hill on which a graphical object is positioned, wherein a position of said graphical object is controlled by a position of said user object, such that a force having a stiffness is applied to said user object when said graphical object is moved across said hill.

13. A method as recited in claim 10 wherein said graphical object controlled by said user object is a ball that may be rolled across said hill.

14. A method as recited in claim 11 wherein said stiffness of said force is negative when said hill has a downward slope, and wherein said stiffness is positive when said hill has an upward slope.

15. A method as recited in claim 1 wherein said selected force sensation is a texture condition, and wherein said graphical representation includes images of a plurality of bumps representing a spacing and density of said texture.

16. A method as recited in claim 13 wherein a spacing an d density of said bumps can be adjusted by said user by dragging at least one control point displayed in said design interface.

17. A method as recited in claim 1 wherein said selected force sensation is a periodic force sensation, and wherein said graphical representation is an image of a periodic waveform.

18. A method as recited in claim 15 wherein said characterization includes specifying an envelope for said periodic waveform, said envelope being displayed in said graphical representation.

19. A method as recited in claim 1 further comprising displaying a graphical representation of a second force sensation selected and characterized by said user, wherein both said selected force sensations are commanded to be simultaneously output on said user object.

20. A method for implementing a force sensation design interface for designing a slope condition, the method comprising:

displaying said force sensation design interface on a display device of a host computer, said force sensation design interface including a graphical representation of a slope condition;

receiving input from a user to said force sensation design interface, said input defining physical characteristics of said slope condition to be commanded by said host computer and output by a force feedback interface device, said force feedback interface device including a user manipulatable object graspable by a user and moveable in a degree of freedom;

adjusting said graphical representation of said slope condition in accordance with said input from said user;

receiving input from said force feedback interface device indicating said user is moving said user object, and commanding said characterized slope condition to said force feedback interface device such that actuators of said force feedback interface device output forces of said

slope condition on said user object in conjunction with updating said graphical representation to reflect a current position of said user object, said graphical representation providing said user with a visual demonstration of a feel of said characterized slope condition.

21. A method as recited in claim 20 wherein said graphical representation of said slope condition includes an image of a hill and a graphical object positioned on said hill, wherein a position of said graphical object corresponds to a position of said user object.

22. A method as recited in claim 21 wherein said graphical object is a ball that may be rolled up or down said hill.

23. A method as recited in claim 21 wherein said forces of said slope condition have a negative stiffness, wherein a side of said hill corresponding to said negative stiffness has a downward curvature.

24. A method as recited in claim 23 wherein the further said ball is moved down said side of said hill, the greater the force pushing said user object away from a center position of said user object.

25. A method as recited in claim 21 wherein said forces of said slope condition have a positive stiffness, wherein a side of said hill corresponding to said positive stiffness has an upward curvature.

26. A method as recited in claim 25 wherein the further said ball is moved up said side of said hill, the greater the force pushing said user object toward a center position of said user object.

27. A method as recited in claim 22 wherein one side of said hill has a downward slope indicating a force with a negative stiffness in one direction, and wherein the other side of said hill has an upward slope indicating a force with a positive stiffness in the other direction.

28. A system for allowing a user to intuitively design spatially varying force feedback sensations, said system comprising:

a host computer system displaying a force feedback design interface on a display device, said force feedback design interface displaying a graphical representation of a force sensation selected by a user, wherein said user can adjust characteristics of said selected force sensation by inputting information to said design interface, said characteristics including stiffness, deadband and offset parameters;

a force feedback interface device coupled to said host computer system, said force feedback interface device receiving said stiffness, deadband and offset parameters and outputting said selected force sensation on a user object of said interface device when commanded by said host computer system, wherein said interface device outputs a modified force sensation on said user object corresponding to adjustments to said force sensation made by said user; and

saving said stiffness, deadband, and offset parameters to a storage medium accessible by said host computer system, said parameters being provided with an identifier to identify said parameters as a set defining a particular force sensation.

29. A system as recited in claim 28 wherein said force feedback interface device includes a microprocessor separate from said host computer system, said microprocessor receivng commands from said host computer system, reading sensors of said interface device and reporting positions of said user object to said host computer, and commanding actuators of said interface device to output said force sensation on said user object.

30. An apparatus providing a force sensation design interface for designing a force sensation to be output to a force feedback interface device, the apparatus comprising:

means for displaying said force sensation design interface on a display device of a host computer, said force sensation design interface including a graphical representation of a force sensation;

means for receiving input from a user to said force sensation design interface, said input defining physical characteristics of said force sensation to be commanded by said host computer and output by a force feedback interface device, said force feedback interface device including a user manipulatable object graspable by a user and moveable in a degree of freedom;

means for adjusting said graphical representation of said force sensation in accordance with said input from said user; and

means for receiving input from said force feedback interface device indicating said user is moving said user object, and commanding said characterized force sensation to said force feedback interface device such that actuators of said force feedback interface device output said force sensation on said user object in conjunction with updating said graphical representation to reflect a current position of said user object, said graphical representation providing said user with a visual demonstration of a feel of said characterized force sensation.

means for writing data describing said physical characteristics of said force sensation to a storage medium.

31. A computer readable medium including program instructions for providing a force sensation design interface implemented by a computer, said program instructions performing steps comprising:

displaying a design interface on a display device of a computer;

receiving input in said design interface from a user, said input selecting a type of force sensation to be commanded by a host computer and output by a force feedback interface device, said force feedback interface device including a user manipulatable object graspable by a user and moveable in a degree of freedom;

receiving input from a user to specify parameters which define characteristics of said selected force sensation;

displaying a graphical representation of said characterized force sensation in said design interface, wherein said graphical representation includes visual representations of said parameters such that said user can view an effect of said parameters on said force sensation; and

commanding said characterized force sensation to said force feedback interface device coupled to said host computer such that actuators of said force feedback interface device output said force sensation on said user object in conjunction with a visual demonstration of said feel of said characterized force sensation.

32. A computer readable medium as recited in claim 31 including program instructions for writing said parameters to a storage medium, said parameters being accessible to application programs implemented on said computer and controlling force feedback.

33. A computer readable medium as recited in claim 32 including program instructions for updating said graphical representation in accordance with said force sensation being output on said user object.

34. A computer readable medium as recited in claim 32 wherein said visual demonstration includes moving a graphical object in correspondence with said user object, wherein when said force sensation is output on said user object, said graphical object engages an image of said representation.

35. A computer readable medium as recited in claim 34 wherein said image of said representation includes an image of a spring displayed for a spring force sensation.

36. A computer readable medium as recited in claim 34 wherein said image of said representation includes an image of a column of liquid displayed for a damping force sensation.